

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A system for actively damping low-frequency coloration of sound comprising:

a listening room including a sound source, said listening room defining at least one mode of low-frequency coloration attributable to said listening room;

an acoustic wave sensor positioned within said listening room, wherein said acoustic wave sensor is operative to produce a first signal representative of said at least one mode of low-frequency coloration;

an acoustic wave actuator responsive to a second signal and positioned within said listening room; and

an electronic feedback controller defining an input coupled to said first signal and an output, wherein

said electronic feedback controller is operative to generate said second signal at said output by applying a feedback controller transfer function to said first signal,

said feedback controller transfer function comprises a second order differential equation including a first variable representing a predetermined damping ratio and a second variable representing a tuned natural frequency,

said second variable representing said tuned natural frequency is selected to be tuned to said at least one mode of low-frequency coloration,

said feedback controller transfer function defines a frequency response having a characteristic maximum gain substantially corresponding to the value of said at least one mode of low-frequency coloration,

said feedback controller transfer function creates a 90 degree phase lead substantially at said at least one mode of low-frequency coloration,

said feedback controller transfer function is augmented by the inverse of an acoustic wave actuator transfer function of said acoustic wave actuator to produce an augmented feedback controller transfer function, and

said augmented feedback controller transfer function is as follows:

$$\frac{V(s)}{P(s)} = G \frac{s^2 + 2\zeta_s \omega_s s + \omega_s^2}{s^2 + 2\zeta \omega_n s + \omega_n^2}$$

where the units of $V(s)$ corresponds to said rate of change of volume velocity, $P(s)$ corresponds to the pressure at the location of said acoustic wave sensor and said acoustic wave actuator, s is the Laplace variable, ζ represents a damping ratio of an acoustic damping controller, ζ_s represents ~~[[a]]~~ the damping ratio of said acoustic wave actuator, ω_n is said tuned natural frequency, ω_s ~~is a~~ represents the natural frequency of said acoustic wave actuator, and G is a gain value.

2. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said first signal represents pressure sensed by said acoustic wave sensor and said second signal represents a rate of change of volume velocity to be produced by said acoustic wave actuator.

3. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein

said first signal represents pressure sensed by said acoustic wave sensor,

said second signal represents a rate of change of volume velocity to be produced by said acoustic wave actuator, and wherein

said feedback controller transfer function is as follows:

$$\frac{V(s)}{P(s)} = G \frac{s^2}{s^2 + 2\zeta \omega_n s + \omega_n^2}.$$

where the units of $V(s)$ corresponds to said rate of change of volume velocity, $P(s)$ corresponds

to the pressure at the location of said acoustic wave sensor and said acoustic wave actuator, s is the Laplace variable, ζ is a damping ratio, ω_n is said tuned natural frequency, and G is a gain value.

4-5. (Canceled)

6. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein

said first signal represents pressure sensed by said acoustic wave sensor,

said second signal represents a rate of change of volume velocity to be produced by said acoustic wave actuator.

7. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said feedback controller transfer function defines a frequency response and wherein the gain of said frequency response increases substantially uniformly from a minimum frequency value to an intermediate frequency value to define a characteristic maximum gain and decreases substantially uniformly from said intermediate frequency value to a maximum frequency value.

8. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 7 wherein said intermediate frequency value corresponds to said at least one mode of low-frequency coloration.

9. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said first variable representing said predetermined damping ratio is a value between about 0.1 and about 0.35.

10. (Previously Presented) The system for actively damping the low-frequency coloration of

sound as claimed in claim 1 wherein said first variable representing said predetermined damping ratio and said second variable representing said tuned natural frequency are selected to damp said at least one mode of low-frequency coloration.

11. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said second variable representing said tuned natural frequency is selected to be substantially equivalent to a natural frequency of a target acoustic mode of said at least one mode of low-frequency coloration.

12. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 11 wherein said target acoustic mode comprises the lowest frequency audible mode of low-frequency coloration.

13. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said second variable representing said tuned natural frequency is selected to be a value between adjacent frequency modes.

14. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said electronic feedback controller is further operative to invert the phase of said second signal.

15. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said acoustic wave actuator introduces characteristic acoustic dynamics into said system and wherein said electronic feedback controller is operative to introduce inverse actuator dynamics into the system.

16. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein

said electronic feedback controller comprises an acoustic damping controller programmed to apply said feedback controller transfer function, and wherein
said acoustic damping controller is configured to selectively damp or treat greater than one frequency mode of coloration.

17. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 16 wherein said acoustic damping controller is positioned within said listening room.

18. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said first signal and said second signal comprise respective electric signals.

19. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said acoustic wave actuator and said acoustic wave sensor are positioned to correspond to the location of an acoustic anti-node of a target acoustic mode within said listening room.

20. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said acoustic wave sensor is a microphone.

21. (Previously Presented) The system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said acoustic wave actuator is a subwoofer.

22-24. (Canceled)

25. (Currently Amended) A system for actively damping the low-frequency coloration of sound comprising:

a listening room including a sound source, said listening room defining at least one mode

of low-frequency coloration attributable to said sound source;

an acoustic wave sensor positioned within said listening room, wherein said acoustic wave sensor is operative to produce a first signal representative of said at least one mode of low-frequency coloration, and wherein said first signal represents pressure sensed by said acoustic wave sensor;

an acoustic wave actuator responsive to a second signal and positioned within said listening room, wherein said acoustic wave actuator is substantially collocated with said acoustic wave sensor, wherein said second signal represents a rate of change of volume velocity to be produced by said acoustic wave actuator, and wherein said acoustic wave actuator introduces acoustic dynamics into said system; and

an electronic feedback controller defining an input coupled to said first signal and an output, wherein

said electronic feedback controller is operative to generate said second signal at said output by applying a feedback controller transfer function to said first signal, invert the phase of said second signal, and to introduce inverted actuator acoustic dynamics into said second signal,

said feedback controller transfer function comprises a second order differential equation including a first variable representing a predetermined damping ratio and a second variable representing a tuned natural frequency,

said second variable representing said tuned natural frequency is selected to be tuned to said at least one mode of low-frequency coloration, and wherein said feedback controller transfer function is as follows

$$\frac{V(s)}{P(s)} = G \frac{s^2}{s^2 + 2\zeta\omega_n s + \omega_n^2},$$

where the units of $V(s)$ corresponds to said rate of change of volume velocity, $P(s)$ corresponds to the pressure at the location of said acoustic wave actuator and said acoustic wave sensor, G represents a weighting factor, ζ is a damping ratio, ω_n is said tuned natural frequency, and G is a gain value,

said feedback controller transfer function defines a frequency response having a characteristic maximum gain substantially corresponding to the value of said at least one mode of low-frequency coloration,

said feedback controller transfer function creates a 90 degree phase lead substantially at said at least one mode of low-frequency coloration,

said intermediate frequency value corresponds to said at least one mode of low-frequency coloration, and

said feedback controller transfer function is augmented by the inverse of an acoustic wave actuator transfer function of said acoustic wave actuator to produce an augmented feedback controller transfer function, and

said augmented feedback controller transfer function is as follows:

$$\frac{V(s)}{P(s)} = G \frac{s^2 + 2\zeta_s \omega_s s + \omega_s^2}{s^2 + 2\zeta \omega_n s + \omega_n^2}$$

where the units of $V(s)$ corresponds to said rate of change of volume velocity, $P(s)$ corresponds to the pressure at the location of said acoustic wave sensor and said acoustic wave actuator, s is the Laplace variable, ζ represents a damping ratio of an acoustic damping controller, ζ_s represents [[a]] the damping ratio of said acoustic wave actuator, ω_n is said tuned natural frequency, ω_s ~~is a~~ represents the natural frequency of said acoustic wave actuator, and G is a gain value.

26-36. (Canceled)